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Staphylococcus* phytotherapy: An overview on the most important Iranian native medicinal plants effective on *Staphylococcus aureus

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ABSTRACT

Staphylococcus aureus exists everywhere such as respiratory tract and skin of adults and it is considered as one of the important factors for nosocomial and outpatient infections such as Endocarditis, Osteomyelitis, Toxic shock syndrome, Abscess, Pneumonia, Meningitis, etc. The aim of this study was presenting an overview on the most important Iranian native medicinal plants affecting on *Staphylococcus aureus*. All required information was obtained by searching key words such as *S. aureus*, medicinal plant extracts or essential oils of published articles in authentic scientific databases such as PubMed, Sciencedirect, Blackwell wiley, Springer, Google scholar, Scientific information database (SID) and Magiran. *Plantago psyllium* (Fleawort), *Aloe vera*, *Zataria multiflora* (thyme), *Achillea wilhelmsii* (yarrow), *Avicennia marina* (mangrove), *Nerium oleander* (oleander), *Allium sativum* (garlic), *Trigonella foenum* (fenugreek), *Teucrium polium* (Poleigamander), *Cichorium intybus* L. (chicory), *Lavandula stoechas* (lavender) and *Salvia leriifolia* Benth (common sage) are the most important plants which have antibacterial effects on *staphylococcus aureus*. Results of this study showed that antioxidant compounds and flavonoids such as Thymol, Carvacrol, Camphor, Cineol, Tannins, Allicin and Tripenes are active antimicrobial and antifungal compounds. Many antimicrobial properties of plant extracts are due to presence of phenolic compounds, polyphenolic acids, terpenoids, essential oils, alkaloids, sulfuric compounds and so on, in different parts of plants such as roots, leaves, buds, seedlings and skin. Since the use of these compounds as anti-staphylococcal effect has been proved, specific tests can be performed for production of bioactive herbal drugs against this bacterium.

KEY WORDS: *Staphylococcus aureus*, Herbal medicines, Medicinal plants, Iran.

1. INTRODUCTION

Infectious diseases as the most well-known diseases have become more common and cause suffering human with serious problems, especially in undeveloped countries. Numerous attempts are carried out to determine their causes, as well as finding treatment and control approaches (Fatholahzadeh, 2009; Rafieian-Kopaei, 2013; Asadollahi, 2012; Bagheri, 2013; Rafieian-Kopaei, 2012; Rahimian, 2014; Sharafati, 2011). *Staphylococcus aureus* is an important gram positive pathogen which can grow in the human skin. 25-30 % of people with presence of *S. aureus* around their nostrils, without clinical symptoms are known as the most important reservoirs of this bacterium (Shopsin, 2001). *S. aureus* exists everywhere such as respiratory tract and on the skin of adults and is considered as one of the most important factors for nosocomial and outpatient infections such as Endocarditis, Osteomyelitis, Toxic shock syndrome, Abscess, Pneumonia, Meningitis and etc. (Kluytmans, 1997). Disease treatment using medicinal plants has been carried out since the beginning of human creation (Sewell and Rafieian-Kopaei, 2014; Nasri, 2014; Mardani, 2014; Rabiei, 2014; Setorki, 2013; Nasri and Rafieian-Kopaei, 2013; Rahnema, 2015). In recent years, using of medicinal plants has increased due to less complications, lower cost and patient compliance to these drugs (Rafieian-Kopaei, 2014; Nasri, 2015; Rafieian-Kopaei, 2011; Nasri, 2015; Asgari, 2013; Rafieian-Kopaei, 2014; Mirhosseini, 2014). It is also estimated that at least one third of all medicinal products has plant origin (Bahmani, 2014; Bahmani, 2012; Delfan, 2014; Bahmani, 2014; Bahmani, 2015; Sarrafchi, 2015; Bahmani, 2012; Eftekhari, 2012; Bahmani, 2013; Gholami-Ahangaran, 2012; Bahmani, 2013; Forouzan, 2012; Gholami-Ahangaran, 2012). Numerous medical properties of plants have been listed in documents such as Avicenna books which their effect have been proved scientifically (Bahmani, 2014; Bahmani, 2015; Delfan, 2014; Bahmani, 2014; Asadi-Samani, 2014). Over years, natural remedies especially herbal medicines have been considered the only means of treatment in some cases (Bahmani, 2014; Delfan, 2014; Saki, 2014; Bahmani, 2014; Khosravi-Boroujeni, 2012; Asadbeygi, 2014; Karamati, 2014).

Plants synthesize some materials to combat and defend against insects and microorganisms. These antimicrobial metabolites effect on natural growth of the microorganisms (Bahmani, 2014; Saki, 2014; Bahmani, 2014; Karamati, 2014). The studies on medicinal plants in order to discover new therapeutic approaches with fewer side effects and more economically valuable have become very important in the world (Bahmani, 2014). Nowadays,

according to published reports, more than 30 percent of herbal medicines are used in hospitals and clinics (Bahmani, 2014). Antibiotics are the main drugs in the treatment of bacterial infections, but due to increasing antibiotic resistance and side effects of these medications, auxiliary methods such as using medicinal plants for treatment is particularly important (Sharafati-chalesshtori, 2014). Bacteria can quickly become resistant to antibiotics and can simultaneously have resistance to several antibiotics (Amanpour, 2015; Rahimian, 2013).

Due to the prevalence of antibiotic resistance in *S. aureus* bacteria, identification of effective medicinal plants is necessary for finding natural active pharmaceutical ingredients for production of herbal antibiotics against staphylococcus. Hence, the aim of this study was presenting an overview on the most important Iranian native medicinal plants affecting on *Staphylococcus aureus*.

2. MATERIALS AND METHODS

All required information was obtained by searching key words such as *S. aureus*, medicinal plant extracts or essential oils of published articles in authentic scientific databases such as PubMed, Science direct, Blackwell wiley, Springer, Google scholar and scientific information database (SID) and Magiran.

3. RESULTS

Effective medicinal plants effective against *Staphylococcus aureus* are listed in Table 1. The results of this review indicated that the most important plants that have anti-staphylococci effect include *Plantago psyllium* (Fleawort), *Aloe vera*, *Zataria multiflora* (thyme), *Achillea wilhelmsii* (yarrow), *Avicennia marina* (mangrove), *Nerium oleander* (oleander), *Allium sativum* (garlic), *Trigonella foenum* (fenugreek), *Teucrium polium* (Poleigamander), *Cichorium intybus* L. (chicory), *lavandula stoechas* (lavender) and *Salvia leriifolia* Benth (common sage).

Table.1.List of effective Iranian native medicinal plants against *S.aureus*

Scientific name	Plant Family	Persian name	Discussion
<i>Plantago psyllium</i>	Plantaginaceae	Espharzeh	Inhibition growth zone of hydroalcoholic extract of <i>P. Psyllium</i> at a concentration of 40 mg/ml of <i>Staphylococcus epidermidis</i> and <i>Staphylococcus aureus</i> is equivalent to 13 and 10 mm, respectively. With doubling the concentration (80 mg/ml), maximum diameter of growth inhibition for <i>S.aureus</i> and <i>S. epidermidis</i> are 20 mm and 18 mm, respectively (Sharifi, 2011)
<i>Aloe vera</i>	Xanthorrhoeaceae	Aloevera	Growth inhibition Diameter and minimum inhibitory concentrations of aloe vera on <i>S. aureus</i> was 2.23 mg/ml (Sadria, 2014)
<i>Scrophularia striata</i>	Scrophulariaceae	Gole meimoonye sazouee	Aqueous extracts inhibited 80% of bacterial growth comparing with control samples and extract's low dose has higher inhibition effects than tetracycline (Ardeshtiri-lajimi, 2013).
<i>Zataria multiflora</i>	Lamiceae	Avishan shirazee	Obtained results showed that the essential oil of <i>Zatharia multiflora</i> has good inhibition effects on resistant <i>S. aureus</i> to tetracycline, erythromycin, trimethoprim-sulfamethoxazole, and methicillin, isolated from food (Soltandelan, 2012).
<i>Achillea Wilhelmsii</i>	Asteraceae	Boumadaran	Methanol extract of the leaves and flowers of <i>A. Wilhelmsii</i> has anti <i>S. aureus</i> effect at a concentration of 400 mg/ml to (Amjad, 2011)
<i>Avicennia marina</i>	Acanthaceae	Harra	Maximum inhibitory concentrations of the <i>A. marina</i> extract on <i>Staphylococcus aureus</i> was 7.9 mg/ml (Anonime, 2004).
<i>Nerium oleander</i>	Apocynaceae	Kharzahreh	<i>S. aureus</i> was sensitive to <i>N. oleander</i> aqueous extract of flowers and leaves at a concentration of 50 mg/ml (Hamoun-navard, 2013).
<i>Allium Sativum</i>	Liliaceae	sir	Minimal inhibitory concentration and maximum inhibitory concentration on <i>S. aureus</i> of 1.25 mg/ml <i>A. Sativum</i> extract were 58.82% and 23.52%, respectively (Bokaeian, 2015).
<i>Trigonella foenum</i>	Fabaceae	Shanbalileh	Minimum inhibitory concentration (MIC) of <i>T. foenum</i> leaf extract on <i>Staphylococcus aureus</i> was 64 mg/ml and growth inhibition diameter was 23 mm (Majnoui, 2010).
<i>Teucrium polium</i>	Lamiaceae	Kalpooreh	Results of a study showed that <i>T. polium</i> extract on <i>S. aureus</i> formed a growth inhibition diameter of 28 mm while was 15 mm for tetracycline (Moghtader, 2013).

<i>Cichorium Intybus L.</i>	Compositae	Kasnee	Alcoholic extract of <i>C. Intybus L.</i> has antibacterial effect on <i>Staphylococcus aureus</i> , but it was less effective than gentamicin and cephalixin (Ghaderi, 2003).
<i>lavandula stoechas</i>	Lamiaceae	Lavandula	Alcoholic extract of <i>L. stoechas</i> at a concentration of 20 and 30 mg has significantly inhibitory effect on the growth of <i>Staphylococcus aureus</i> bacteria in 15.06 to 15.58 mm diameter (Khosravi and Malecan, 2004).
<i>Salvia leriifolia</i>	Lamiaceae	Norouzak	Obtained results showed that the highest and lowest anti <i>S. aureus</i> effects of <i>S. leriifolia</i> powder was 20000 and 5000 mg/kg (Yousefli, 2011).

4. DISCUSSION

The plants introduced here have various active components. The most important phytochemical compounds of these plants are discussed below: Thymol and Carvacrol in *Z. multiflora* (Zargari, 1993), Inulin in *C. intybus L.* (Kaur and Gupta, 2002), Camphor, Borneol, Cineole, Camphene and a Terpene known as Myrcene in *A. Wilhelmsii* (Mozaffarian, 2004), Diosgenin, Yamogenine and Trigonelin in *T. foenum* (Anis and Aminuddin, 1985), Terpenoids, Saponins, Flavonoides, Tannins and Alkaloids including seventeen terpenes such as Cineole, Borneol, E-ionol in *S. leriifolia* Benth plant (Mozaffarian, 2004) are the main phytochemical ingredients. Phytoalexines, Esteroides, Tannins, Carboxylic acids, Flavonoids, Iridioides and Tripenes are the main components of *A. marina* (Bandaranayake, 2002). The main compounds in *L. stoechas* are Myrcene, Cymene, Linalool, Caryophyllene, Camphor, and Linalyl acetate (Ghelardini, 1999). Anthraquinone in *Aloe vera* is the most effective component (Tanaka, 2006). Main bioactive compounds of *T. polium* plant include 10 terpenes such as Sesquiterpenes, Diterpnoides, Germacrene, Caryophyllene and Spathulenol (Hassan, 1979). *P. psyllium* contained organic acids such as Benzoic acid, Capheic acid, Fumaric acid, Ascorbic acid, as well as Alkaloides, Amino acids and Polysaccharides (Zargari, 1993). Allicin is one of the main compounds of *A. sativa* (Nasri, 2013; Shirzad, 2011).

Many antimicrobial properties of plant extracts are due to presence of phenolic compounds, polyphenolic acids, terpenoids, essential oils, alkaloids, sulfuric compounds and so on, in different parts of plants such as roots, leaves, buds, seedlings and skin (Taghikhani, 2014; Madihi, 2013; Sarrafzadegan, 2013; Nasri, 2014; Setorki, 2011). Furthermore, there are a lot of other plants which have these compounds (Rafieian-Kopaei, 2014; Nasri and Rafieian-Kopaei, 2014; Baradaran, 2014; Nasri, 2014). Hence they also may have antimicrobial activities and worth examining. More importantly, the phenolic compounds in plants have antioxidant activities which have various beneficial effects (Baradaran, 2013; Nasri, 2014; Rafieian-Kopaei, 2013; Nasri, 2013; Baradaran, 2013). Infectious diseases have been shown to be associated with oxidative stress (Bagheri, 2013). This oxidative stress is predominantly due to free radicals which cause various complications (Nasri and Rafieian-Kopaei, 2013; Madihi, 2013). The plants antioxidants can scavenge these free radicals not only in infectious disease, but also in other conditions such as atherosclerosis (Asgary, 2014; Asgary, 2013), diabetes (Rafieian-Kopaei, 2014; Baradaran, 2013; Behradmanesh, 2013), burns or surgical wounds (Asadi, 2013; Parsaei, 2013), neurodegenerative diseases (Rabiei, 2014) as well as some toxicities (Heidarian, 2013). Therefore, other than antimicrobial activity, they have various beneficial properties.

Giving to increasing antibiotic resistance due to high using of antimicrobial agents for the prevention and treatment of infections as well as their side effects, implementing researches on medicinal plants in order to discover new sources of drugs against bacterial infections are necessary. Therefore, since the use of these compounds as anti-staphylococcal effect has been proved, specific tests can be performed for production of bioactive herbal drugs against this bacterium.

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